THE GRAPHIC METHOD OF REPRESENTING MUSICAL INTERVALS *

THE object of the paper was to explain a method of representing musical intervals, which was very useful in giving a clear idea to the mind of relations often complex and obscure.

The author pointed out that there was a natural tendency to refer the positions of musical notes to positions in space. It was by no means clear that there was any real physical or physiological relation between the two things, but somehow or other the idea had become so firmly rooted in the mind that it had developed itself in expressions of every-day use. For example, it was customary to call a note with rapid vibrations a *high* note, and one with slow vibrations a *low* note. Few people considered whether there was any natural justification for these terms; probably there was none, but they had existed almost ever since music had taken a definite form, and had given rise to the form of notation employed to express the positions of musical sounds.

It followed from this that the musical idea of distance between two notes, which was technically called a musical interval, might be considered as having an analogy between the high and low positions of the two notes respectively, a greater interval being represented by a greater space, and *vice versâ*; and carrying this idea out to its full extent it became possible to represent musical intervals to the eye in such a way as to convey ideas of comparative magnitude precisely analogous to the impressions which these intervals would make on the ear. This the author called the *graphic* method of representing intervals.

The idea of such a method had been embodied from early times in the word *scale*, which was derived from the Latin *scala*, a ladder, thereby clearly implying an analogy between the spaces of the steps and the intervals of the notes. Mr. Hullah, in some of his elementary books, had actually made use of a diagram of a ladder for this purpose, and he had introduced the improvement of representing the intervals between the third and fourth and between the seventh and eighth steps (of the diatonic major scale) as only half the length of the other degrees, thereby embodying, in a graphic mode, the distinction in magnitude between the whole tones and the semitones. What the author proposed to do in this paper was merely to establish this mode on definite principles, and to give it more capability and more accuracy.

It was well known that the scientific definition of a musical interval was expressed by the ratio which the vibration-number of the higher sound bore to that of the lower one, and it had been shown that the idea of the magnitude of the interval in a musical sense might be expressed by the logarithm of this ratio. Hence, by plotting down this logarithm with a scale of equal parts, and drawing a line of that length, such a line would be a correct graphic representation of the magnitude of the interval.

The author explained the mode of doing this in a simple practical way, which might be put in practice by anyone, with the aid of a small table of logarithms, as easily as working a simple sum in arithmetic; and he calculated and laid down several examples in the presence of the audience. It would be, he said, sufficiently accurate to express the distances in three places of figures, as, for example:—

The interval of an octave would be expressed by a line whose length was—

= log. 2 ... ... = 301
That of a major—
Sixth = log. $\frac{5}{3}$ ... ... = 222
That of a minor—
Sixth = log. $\frac{8}{5}$ ... ... = 204
That of a fifth—
= log. $\frac{3}{2}$ ... ... = 176
That of a fourth—
= log. $\frac{4}{3}$ ... ... = 125
That of a major—
Third = log. $\frac{5}{4}$ ... ... = 97
That of a minor—
Third = log. $\frac{6}{5}$ ... ... = 79

And so on for any others.

It would be seen how truly these numbers corresponded to the ideas of the intervals existing in musical practice, for, according to the usual musical rules—

Fifth + Fourth ... ... = Octave.
Major Sixth + Minor Third ... ... = Octave.
Minor Sixth + Major Third ... ... = Octave.
Major Third + Minor Third ... ... = Fifth.
Fourth + Minor Third ... ... = Minor Sixth.

And so on.

The author then, as a more extended illustration of the principle, showed the process of determination of the exact positions of the various notes of the modern musical scale, including all the accidental sharps and flats necessary for chromatic purposes and for modulation; and he proceeded to draw the same on a large diagram, making the octave 3 feet long. This enabled the audience to appreciate clearly many delicate points of intonation, which were difficult to be conveyed to the mind by any process of verbal description, and which the author explained and commented on in their theoretical and practical bearings. He also drew a corresponding scale on the plan of equal temperament, and pointed out the more important differences between this and the true scale, concluding with some remarks on the subject of intonation generally.

* Abstract of a paper read by W. Pole, F.R.S., Mus. Doc., Oxon., at the second meeting of the Musical Association for the Advancement of the Art and Science of Music on Dec. 6, at the Beethoven Rooms, Harley Street, Mr. Bosanquet in the chair.

THE SWEDISH ARCTIC EXPEDITION

THE following extracts are taken from a letter addressed to Mr. Oscar Dickson, of Gothenburg by Dr. F. R. Kjellman, who (and not his brother Dr. Theél Kjellman, as was stated by mistake in NATURE, vol. xiii. p. 75) was in command of the *Pröven*, the vessel of the Swedish Arctic Expedition during the return voyage from the mouth of the Jenesei to Norway. The *Pröven* left the mouth of the Jenesei on the 19th August, fell in with ice on the 23rd in 75° 22′ N. lat. and 66° 30′ E. long. from Greenwich; sailed along the edge of the ice until, a little south of Cape Middendorff, it was found to connect itself with the land so as to bar all passage northwards. The *Pröven* then turned south and was carried by a current twelve miles south of Matotschkin Scharr.

"Before going farther I may perhaps be permitted to make some remarks on the higher vertebrate animals which we found to inhabit or visit the Kara Sea. The walrus occurs here plentifully, and has of late years been the object of exterminating pursuit on the part of the Norwegians. At many places on the Samoyede peninsula and White Island we saw great herds of these beautiful animals. The Kara Sea has three species of seals, *Phoca barbata*, *hispida*, and *Grœnlandica*. The last-named was that which we saw most frequently and in greatest numbers. Off Obi and Jenesei white fish (? dolphins) were very common, and on the east coast of Novaya Zemlya we saw a large fin-whale (*fenhval*). If I add that one day, as we lay becalmed between Udde Bay and Matotschkin Scharr, an ice-bear quite unexpectedly came swimming out to our vessel, where he, of course, soon met his death, I have named all the mammalia we saw during our navigation of the Kara Sea. The bird world was exceedingly poor. I may almost say that it was a great rarity to see a tern or a mew. The alka (*Uria Brünnichii*), which occurs in such immense numbers on the west coast of Novaya Zemlya, is believed to be absent on the east coast. We saw here only one, and it appeared to have gone astray. Only some few species of fish were observed."

The *Pröven* passed through Matotschkin Scharr on the 10th and 11th September, arriving at Hammerfest on the 26th of the same month, and at Tromsö on the 3rd October. Dr. Kjellman sums up the scientific results of the expedition as follows:—

"We botanists have endeavoured not only to ascertain what species of plants Novaya Zemlya possesses, but also to get an insight into the varying distribution of the different species, the nature of the vegetation at different localities, in different latitudes, at varying heights above the sea, at varying distances from the seashore, &c. We have made a great number of such observations, and thereby will, I believe, be in a position to give such an account of the vegetation of Novaya Zemlya as will satisfy the requirements of science. Of flowering plants we have rich collections from Matotschkin Scharr, from many places on the west coast of Southern Novaya Zemlya, from Waigats Island and the mainland lying opposite to it, from the Samoyede peninsula and the region lying round Dickson's Harbour, and these collections contain a considerable number of species new to those localities. The phanerogamic vegetation of Novaya Zemlya has a strong resemblance to that of Spitzbergen, but at the same time, as might be expected from

its position, has a more southern stamp. This appears partly by Novaya Zemlya being much richer in species than Spitzbergen, of which species several occur which belong to families not represented on Spitzbergen, and partly by the vegetation of Novaya Zemlya being richer in individuals. At many places, especially in the more southerly parts of the land and the interior of the fiords, the ground is covered with thickly-matted plants, to which there is nowhere on Spitzbergen anything corresponding. Their closeness and variety of colour often awoke our surprise and astonishment. The phanerogamic vegetation of Novaya Zemlya connects itself by means of common species not only with that of Spitzbergen, but also with the floras of Arctic America and northern Norway, and that of the shores of the Gulf of Bothnia and the Asiatic Continent.

"The more southern character exhibited by the phanerogamic vegetation of Novaya Zemlya, as compared with that of Spitzbergen, is as good as absent in its marine algæ. The same dissimilarity is also apparent with regard to the fauna. The land fauna is more southern, the marine fauna is high Arctic. The most of the marine algæ known to exist at Spitzbergen are found at Novaya Zemlya, and of the species collected here there is only one that is wanting on the coasts of Spitzbergen.

"Of fresh-water algæ, mosses, and lichens, we have made considerable collections. Of mushrooms, on the contrary, we obtained very few. Either it was a bad mushroom year on Novaya Zemlya, or else, what is less probable, this class of plants is very sparingly distributed on these islands.

"As on the coasts of Greenland and Spitzbergen, so in the parts of the Polar Sea we now visited, the surface of the sea at certain places which appear to be sharply defined is quite full of diatomaceæ. A belt of special richness we found on the north coast of Norway, extending in an easterly direction from North Cape to the mouth of Tana Fiord; another, less rich and of less extent, we found in the neighbourhood of the Samoyede peninsula.

"Through the researches of Th. von Heuglin, we have already a good knowledge of the vertebrates of Novaya Zemlya. The attention of our zoologists has, however, been directed to this group of animals, and by their observations our knowledge of them has been very considerably extended. This specially holds good of the birds.

"Along the whole west coast south of Matotschkin Scharr, as well in the open sea as in the fiords and sound where we sailed through and lay at anchor, dredging has been assiduously carried on. The rich collections thus made will certainly, when they are examined, afford a very complete idea of animal life in this region. Few species of animals were previously known as existing here, and as to the distribution of the different species along that extensive coast all information has hitherto been wanting.

"Among the zoological work'a conspicuous, place is occupied by a rich insect collection by which the knowledge that we previously had of Novaya Zemlya's insect world will be very considerably extended. Formerly from this region only four or five species of insects were known. The expedition's collection consists of about 500 specimens, and includes numerous representatives of nearly all the orders of insects.

"Most important, however, in a zoological aspect, appear to me the numerous dredgings which were carried on in the Kara Sea, and which prove that in this sea there is, as has been already mentioned, abundant animal life of very various types. The collections made here are large, and must be specially valuable for zoological science as coming from a considerable region of the Polar Sea, of which the zoology is little known, but especially because this extent of sea exhibits in different tracts so considerable dissimilarities with respect to depth, content of salt in the water, &c."

BOTANICAL NOTES

The Calcutta Botanical Gardens.—Dr. King's report on the Royal Botanical Gardens, Calcutta, for the year ending March 31, 1875, to which we have recently referred (vol. xii. p. 541), contains some interesting notes on the cultivation of useful plants, especially the Para rubber plant (*Hevea braziliensis*) and the Ipecacuanha (*Cephælis ipecacuanha*). With regard to the former, Dr. King is of opinion that the plants will not thrive in that part of India. Mr. Collins, in his report on the Caoutchouc plants, describes the *Heveas* as growing in their native country in situations where the heat is not generally above 87° Fahr. in the afternoon, and below 74° at night, and shows, on the authority of Wallace, that the temperature in the caoutchouc districts during three years only once reached to 95°, the greatest heat being about 2 P.M., when it ranges from 89° to 94°, and never lower than 73°. The meteorological returns for Calcutta show a wide difference between the Brazilian and the Indian climates. Another Caoutchouc plant, however, the *Vahea madagascariensis*, Boj., a climbing apocyneous shrub, native of Madagascar, promises to thrive much better than the *Hevea*. The fact of the plant being of climbing habit militates considerably against its value as a cultivated plant, owing to the difficulty in providing supports as well as in obtaining the caoutchouc. Nevertheless, it is a kind highly valued in the English market, realising a price next to Para rubber. With regard to Ipecacuanha, which has been shown to require much care and attention as to soil and situation, we learn that a number of sets of plants were put out during the early part of the year at different spots at low elevations in the Cinchona reserve at Sikkim; warm, well sheltered situations, with good virgin soil, were chosen. "Some of the plants thus put out were protected by the natural shade of the forest, others by a sloping thatch of grass. Until the arrival of the cold weather all went well, but the unusually low temperature that prevailed during that season was fatal to the majority of the plants." Dr. King further says that he is "driven reluctantly to the conclusion that it is doubtful whether ipecacuanha can be successfully cultivated as an out-door crop in Sikkim." Further trials, however, are to be made before its experimental cultivation is recommended to be abandoned.

Eucalyptus globulus has had its share of attention in India, and without considering the question of the truth or otherwise of its reputed value, it is proved that although it grows quickly and with vigour on the Neilgherries and Khasia hills at 5,000 to 8,000 feet above the sea, it cannot be induced to live even for a year or two in the hot plains of India. Dr. King's description of the fine old Banyan tree, "one of the greatest curiosities and ornaments of the place," will, we are sure, be read with interest. He says: "Although considerably damaged by the cyclone of 1864, which carried away two of its largest arms, this fine tree continues to grow vigorously. It now covers an area of ground 800 feet in circumference; its trunk girths 51 feet, and from its branches no fewer than 170 aërial roots are sent down to the ground, some of them being more than ten feet in circumference. This fine old tree supports quite a colony of orchids, ferns, and creeping plants of about twenty distinct species, and gives shelter to innumerable birds. Its exact age is not known, but, considering how rapidly banyans grow, it probably does not much exceed that of the garden, and is therefore less than a century."

Gum Arabic.—In a recent number of the *Revue des Sciences Naturelles*, Prof. Charles Martins, of Montpelier, draws attention to a peculiar mode of exudation of gum arabic from the *Acacia verek* of Senegal. On the authority of Schweinfurth, quoted in the "Pharmacographia," p. 206, it is stated that this tree, exclusively, yields the fine white gum of the countries bordering the Upper Nile, and especially of Kordofan. It is described as growing to a height of about twenty feet, and though the gum is one of the principal productions of the colony, being collected in large quantities by the Moors, who exchange it for European commodities, no notice occurs of any peculiarity in its formation or collection; indeed, it is stated that "the gum generally exudes from the trees spontaneously, in sufficient abundance to render wounding the bark superfluous. The Somali tribes of East Africa, however, are in the habit of promoting the outflow by making long incisions in the stem and branches of the tree. In Kordofan the lumps of gum are broken off with an axe, and collected in baskets." Prof. Martins shows that the exudation of the gum is often promoted by the growth of a species of Loranthus, his observations being founded on actual specimens of branches of the Acacia upon which the parasite had formed. In several instances the gum had exuded in a vermicular form always at the point of union of the parasite with the stock. This union of the two plants forms, as is usual with other Loranthaceous species, an irregular, gnarled-like protuberance, from which are given off both the branches of the Acacia and also of the Loranth, each of which is very distinct from the other, those of the Acacia being spiny and more slender than those of the parasite. Rather than this mode of exudation being rare, it would seem to be of frequent occurrence. M. Martins considers the parasite to be a new species of Loranthus, for which he proposes the name of *Loranthus senegalensis*, placing it near *L. pentagonia*, DC.